THE MOVEMENTS OF THE EARTH[1]

VI.

WE have now to consider some of the results of these Movements of the Earth—first round its own axis, its rotation; then round the sun, its revolution—which we have been considering, results to which of course a general interest attaches, and which there will be no difficulty in showing are of very great importance to us. Occasion was taken to point out that the different appearance presented by the sun and the stars was simply due to the fact that the sun was very near to us whilst the stars were very distant, the one, a sun which happens to be near to us, the others, also suns, but happening to be very far removed from us. Now suppose we have a globe in which we have an electric light, to represent the sun, and a little globe to represent the earth, then it will be obvious that that part of the earth which is turned towards the lamp will be bathed in light, while that half which is turned from it will be in darkness, being, so to speak, only under the light of the distant stars. This shows us the reason for that great difference which we call day and night, and we can quite understand how it is that we get the apparent rise of the sun which occurs when the part of the globe on which we live is carried from the darkness into the light, and sunset which of course occurs when the globe is being carried by its rotation from the light into the darkness. This phenomenon of day and night is thus one of the most obvious results of the rotatory movement of the earth, and one which might have been dismissed in two words had we so chosen, but we will dwell upon it for a few moments, because this fundamental difference between day and night furnishes us with a reason why we should discard that sidereal time to which up to the present reference has alone been made.

49.—Diagram showing how the difference between the lengths of the sidereal and mean day arises.

Fig. 49 will show how it is that under the circumstances in which we thus find ourselves, a new kind of time must take the place of sidereal time. In this diagram we have the earth represented at two positions in its orbit, 1 and 2. It travels in this orbit in the direction of the arrows, rotating on its axis the while in the direction also indicated by arrows. Now let us consider the start-point 1, and suppose that when the earth occupies this position a particular star is on the meridian at midnight. The earth it will be remembered rotates in twenty-four sidereal hours; it will therefore take twelve hours to turn half round, so that if we consider the sun to be directly opposite the star which is south at midnight it is obvious that they are twelve hours apart. Now consider the earth at position 2. Then remembering this fundamental fact, that the distance of the stars is so enormous that a string stretched from the observer to the star at one point of the earth's orbit would be practically parallel to a string stretched to the same star from any other part of the orbit; it is obvious that the star will have the same right ascension in both positions of the earth, and the line pointing to the star will be practically in the same direction. But the sun will no longer lie along the prolongation of the line joining earth and star as it did at 1, for in consequence of the earth's revolution round the sun we shall get a gradually increasing angle as the earth in its orbital course gets farther and farther from its initial position at 1. Now it is obvious if we are going to have our time regulated by the sun instead of by the stars—and that is what we must do for the purposes of civil life—we shall have to arrange our clock so that when we pass from 1 to 2 it must, if it showed 12 o'clock when the sun was due south in the former position, show 12 o'clock also when the sun is due south in the latter position. If this be so, and we have this angle made by the line joining sun and earth and star, we shall have to make our sun-clock go more slowly than our sidereal clock, for the reason that the sidereal clock will have gone round once in less time than the earth will have got round to the same place with regard to the sun. But if we choose, and we do choose, to say that we will have twenty-four hours from sun-southing to sun-southing, then these twenty-four hours and necessarily also their minutes and seconds, will be longer than the hours, minutes, and seconds of sidereal time. Let us take another illustration. Consider the case of the earth in three different positions, represented by three globes round a central lamp. Then suppose that in each of these globes a wire is put to represent the direction in which the transit instrument points at Greenwich when the same star is observed at three consecutive intervals of twenty-four hours of sidereal time. These three wires should therefore be placed parallel to each other. Now let us take the electric lamp to represent the sun, then we shall find that, when the transit instrument on each of the earths is brought round to point at the sun, the three wires which represent the instruments will not be parallel to each other but at some angle. At first sight it might seem that we could easily get a sun-time to replace the star-time, but unfortunately when we go a little deeper into it we find, as we often do in other cases, that it is not quite so easy—and for two reasons. We found, it will be remembered, when we came to consider the form of the earth's orbit, that it was not quite circular, that it was in fact what is called an ellipse, and that the radius vector, *i.e.* the imaginary line joining the centres of the sun and earth did not sweep through equal *arcs* in equal times but through equal *areas*, so that, if we want to invent a clock which will show twenty-four hours from the time of sun-southing one day to the time of sun-southing the next, that clock will require to be regulated differently for every day in the year, because the greater or less part of its orbit moved over by the earth will cause the greater or less angle between the lines joining sun, earth, and star.

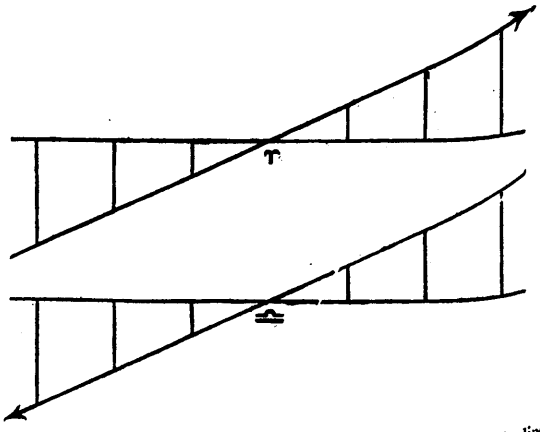

FIG. 50.—Diagram showing how the sun's apparent motion along the inclined lines representing the ecliptic in the direction indicated by the arrow-heads is represented by a smaller amount when referred to the earth's equator (the horizontal lines in the figure) at the spring (♈) and autumn (♎) equinoxes.

That I hope is clear. Thus then there is good reason why this arrangement of having a sun-time from noon to noon will not work. We should have to regulate our clock for every day in the year, or rather for every two opposite days. But there is another matter. We are now in full presence of the fact that the equator of the earth is inclined at an angle of about 23½° to the plane of the ecliptic. Fig. 50 will perhaps enable us to understand this matter more easily. Let the horizontal lines represent the plane of the equator and the inclined lines the

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